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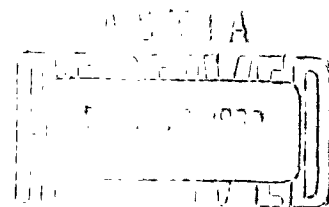
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MATERIAL - BRAZED HONEYCOMB PANELS -
MECHANICAL PROPERTIES OF - REDUCED
BRAZE CYCLE ON - EVALUATION OF -
EFFECT ON

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MATERIALS - BRAZED HONEYCOMB PANELS - MECHANICAL PROPERTIES OF -
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F. C. Nordquist

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for DC Novelt
D. C. Wilson

REVISIONS

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MATERIALS - BRAZED HONEYCOMB PANELS - MECHANICAL PROPERTIES OF -
REDUCED BRAZE CYCLE ON - EVALUATION OF - EFFECT ON

PURPOSE:

The purpose of this investigation was to evaluate the effect of a short time brazing cycle on some mechanical properties of 17-7PH stainless steel used in brazing honeycomb sandwich panels.

SUMMARY:

The tensile properties of 17-7PH stainless steel were determined on .005", .010", .025", .040", and .063" thick sheet material, heat treated according to a rapid brazing cycle. The test results indicated that close control of the aging temperature is necessary to obtain consistently the minimum tensile properties specified in Convair Specification FZS-4-046C.

Four batches of .010" and .025" thick 17-7PH steel filler sheets were heat treated by the Manufacturing Research and Development Department (MR&D) in Convair production brazing furnaces. Tensile specimens from this material gave mostly low to marginal ultimate strength values. The average ultimate strength of 50% of the .010" thick material and 12.5% of the .025" thick material was below the 180 ksi minimum strength specified. It is thought that these low strength values were caused by inadvertent aging at approximately 1075 F.

Tensile specimens of 17-7PH steel sheet were given a rapid brazing cycle heat treatment in the Engineering Test Laboratories (ETL). All material receiving the following cycle had acceptable tensile properties:

Heat Treat Cycle A'

1. Heat to 1650 F in 13-15 minutes
2. Hold at 1650 F for 5 minutes
3. Cool to R. T. in 30 minutes
4. Hold at -20 F for 30 minutes
5. Age at 1065 F for 90 minutes

Specimens heat treated according to Cycle B', with a 90 minute 1400 F conditioning step after step 2 of the above Cycle A', had variable elongation values. Most specimens aged at 1050 F gave low elongation values while most of those aged at 1075 F gave low ultimate strength values.

Notched tensile specimens were tested from material heat treated with:

1. The rapid brazing cycle heat treatment without a 1400 F conditioning step.
2. The rapid brazing cycle heat treatment with a 1400 F conditioning step.
3. A standard production brazing heat treatment.

Unnotched control specimens were processed only with the standard production, P, cycle specimens. The notched strength to ultimate tensile strength (NS/UTS) ratio of these specimens was as follows:

<u>Thickness (Inch)</u>	<u>NS/UTS P Cycle</u>
.005	.94
.010	.95
.025	.94
.040	.96
.063	1.03

Tensile, edge compression, flat compression, and shear beam test specimens from three 17-7PH steel brazed sandwich panels were tested. All three panels received a rapid brazing or A cycle heat treatment. All the test results were above the minimum values specified in FMS-0036(C). Although all the average results were above the required minimum values, the skins of panel #1 and the core of panel #2 were somewhat below normal strength expectations.

MATERIALS - BRAZED HONEYCOMB PANELS-MECHANICAL PROPERTIES OF-
REDUCED BRAZE CYCLE ON-EVALUATION OF - EFFECT ON

The object of this investigation was twofold as follows:

1. To determine whether a short brazing cycle would provide acceptable tensile properties in 17-7PH steel sheet.
2. To determine whether the mechanical properties of 17-7PH brazed panels would be acceptable after such a brazing cycle.

DESCRIPTION OF SPECIMENS:

Standard tensile specimens of 17-7PH steel were prepared as shown in Figure 1. Notched tensile specimens were prepared as shown in Figure 2. Tensile, edge compression, shear, flat compression, and simple beam specimens were cut from each of three brazed sandwich panels and prepared in accordance with drawing 4FTT110 in the FMS-0036(C) specification.

PROCEDURE:

The tensile specimens heat treated in the ETL were taken from .005", .010", .025", .040", and .063" thick 17-7PH steel material. At least two heats of each thickness were tested. Specimens both longitudinal and transverse to the grain direction were tested for each heat and thickness of material. Additional tensile specimens were prepared from four batches of .010" and .025" thick 17-7PH steel filler sheets heat treated in production brazing facilities by the MR&D Department. Three 1/2" x 13" x 25" 17-7PH steel sandwich panels, brazed with sterling silver plus .2% lithium alloy, were process by MR&D and tested in the ETL. These panels were heat treated in accordance with the rapid A cycle.

The following simulated brazing cycles were used in heat treating the test specimens. Each heat treatment was given a letter designation which is used throughout this report in referring to a particular treatment.

Heat Treat Cycle A

1. Heat to 1650 F in 13-15 minutes
2. Hold at 1650 F for 5 minutes
3. Cool to R.T. in 30 minutes
4. Cool to -20 F and hold 30 minutes
5. Age at 1050 F for 90 minutes

Heat Treat Cycle B

1. Heat to 1650 F in 13-15 minutes
2. Hold at 1650 F for 5 minutes
3. Cool to 1400 F and hold 90 minutes
4. Cool to R.T. in 30 minutes
5. Cool to -20 F and hold 30 minutes
6. Age at 1050 F for 90 minutes

Heat Treat Cycle A'

Cycle A' was the same as Cycle A but the aging was at 1065 F instead of 1050 F.

Heat Treat Cycle B'

Cycle B' was the same as Cycle B but the aging was at 1065 F instead of 1050 F.

Heat Treat Cycle P

The P heat treatment was used only on certain notched tensile specimens for comparative purposes. It represents the current brazing cycle for a nacelle type sandwich panel.

1. Heat from 1000 F to 1650 F in 90 minutes
2. Hold at 1650 F for 10 minutes
3. Cool from 1650 F to 1400 F in 45 minutes
4. Cool from 1400 F to 1000 F in 20 minutes and then to R.T.
5. Hold at -20 F for 30 minutes
6. Age at 1050 F for 90 minutes

Armco Heat Treatment

1. Heat to 1400 F and hold 90 minutes
2. Cool to R.T. in 60 minutes
3. Hold at 50 F to 60 F for 30 minutes
4. Age at 1050 F for 90 minutes

Several heats of 17-7PH steel sheet were checked for heat treat response with the above TH 1050 Armco heat treatment.

The heat numbers of the 17-7PH filler sheet material were not known. The tensile results obtained for these sheets, given in Tables I - VIII, are distinguished from each other by batch number. The sheet materials identified by a given batch number were processed together by MR&D.

The heat numbers of all the material heat treated in the ETL are listed in the appropriate tables of test data. For heats referred to as U, V, X, Y, and Z, the heat number was not known.*

All the tensile specimens heat treated in the ETL were processed in 1/4" thick stacks. These stacks were placed in a stainless steel envelope in such a manner that the long axis of the specimens remained vertical during heat treatment. The purpose of this arrangement was to reduce thermal gradients in the specimens when the furnace door was raised during the cooling period. An argon atmosphere was maintained on the specimens during the entire heat treatment.

Both the standard and the notched tensile specimens were tested using Templin grips. The elongations reported were all taken over a 2" reduced section. Yield strength was taken as 0.2% offset from the straight line portion of the stress-strain curve.* All testing was performed on a 5000 lb. or 60,000 lb. Baldwin universal test machine. In testing the brazed sandwich panel specimens, the test fixtures and procedures were in accordance with FMS-0036(C).***

RESULTS:

The results of the tensile tests on 17-7PH material heat treated in production brazing furnaces are listed in Tables I - VIII.

The results of the tensile tests on 17-7PH material receiving a standard Armco TH 1050 heat treatment are listed in Tables IX and X.

The results of the tensile tests on 17-7PH material heat treated in the ETL are listed in Tables XI - XVII.

The results of the notched tensile tests on 17-7PH material are listed in Tables XVIII - XXII.

The results of the 17-7PH brazed panel tests are listed in Table XXIII.

*See Supplemental sheet S-2

**Strain rate was approximately .003 in./in./min. thru yield.

***See Supplemental sheets S-1 and S-2.

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DISCUSSION:

The average tensile values obtained from the 17-7PH steel specimens processed as filler sheets by MR&D were as follows:

Batch	Heat Treat	Thickness (Inch)	Grain Direction	Yield Strength (ksi)	Ultimate Strength (ksi)	% e in 2"
1	A	.010	L	155.7	169.6	6.9
		.010	T	160.0	173.6	5.7
		.025	L	171.1	178.3	5.0
		.025	T	179.4	185.2	4.1
2	A	.010	L	175.0	183.1	6.3
		.010	T	178.4	185.0	5.8
		.025	L	178.3	185.8	8.2
		.025	T	181.1	187.6	7.3
3	B	.010	L	165.0	173.3	9.4
		.010	T	162.6	173.8	9.4
		.025	L	179.5	185.9	8.9
		.025	T	182.6	188.9	8.8
4	B	.010	L	179.4	185.3	6.2
		.010	T	181.1	187.2	5.9
		.025	L	186.3	191.2	7.9
		.025	T	186.7	192.7	6.5

The minimum tensile values specified in FZS-4-046C for brazed 17-7PH steel sheet are:

Thickness (Inch)	Fty ksi	Ftu ksi	% e in 2"
.005 to .0099	150	180	3.5
.010 to .0199	150	180	4.5
.020 and over	150	180	5.5

The tensile test values for the filler sheets did not all meet the minimum specification. Half of the .010" thick specimens were below the 180 ksi ultimate strength minimum. The elongation values from the first batch of .025" thick material were low and

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the .025" thick longitudinal specimens had low ultimate strength. From heat surveys previously carried out, it was known that there were temperature gradients in the General Electric aging furnace. Thus, the aging temperature could have been on the high side, evidently about 1075 F at times. This would account for the low strength and high elongation values.

The specimens of .005", .010", .025", and .040" thick 17-7PH steel heat treated with either the A or B cycle in the ETL had high tensile strengths and low elongations. Only the .063" thick material had elongations above the amount specified in FZS-4-046C. These results were contrary to the results for 17-7PH filler sheets. As indicated in the paragraph above, there was a possibility that the filler sheets had been aged at temperatures approximating 1075 F.

Additional tensile specimens of .005", .010", .025", .040", and .063" thick 17-7PH steel sheet were heat treated and tested. These specimens were given the A or B heat treatment, but the aging temperature was raised to 1065 F. These treatments are designated A' and B' in the tables. The elongation values of all the test specimens receiving the A' heat treatment were above the minima specified for the thicknesses indicated. The ultimate strengths with one exception were above 180 ksi, although they were lower than those of specimens receiving the A or B heat treatment. The exception was heat No. 46979 of .063" thick material. This heat gave quite low ultimate strength values. Tests later showed that this heat of material would not respond to a standard Armco TH 1050 treatment. The test data are given in Tables X and XVI.

Figure 3 is a chart showing the effect of aging temperature on the ultimate strength and percent elongation of specimens receiving a rapid brazing cycle heat treatment. In this chart, all specimens receiving a similar heat treatment were processed together. Also, all specimens of a given thickness were obtained from the same heat of 17-7PH steel. The specimens aged at 1050 F were tested in the transverse grain direction only. Transverse specimens generally give lower percent elongation values than do longitudinal specimens. The elongation was considered the critical property at the 1050 F aging temperature. The specimens aged at 1075 F were tested in the longitudinal grain direction. The ultimate tensile strength is usually lower in longitudinal direction than in transverse direction. Ultimate strength was considered most critical at the 1075 F aging temperature. Both longitudinal and transverse specimens were tested at the 1065 F aging temperature.

The results plotted in Figure 3 are listed in Tables XI, XII, XIII, XV, XVI, and XVII. All the results for material aged at 1075 F are listed in Table XVII. The results of material aged at 1050 F and 1065 F are taken from the other tables just mentioned and are marked with an asterisk. Figure 3 shows that very little variation from the 1065 F aging temperature can be tolerated when the rapid cycle heat treatment is used if a minimum ultimate tensile strength of 180,000 psi is to be maintained.

The specimens receiving the B' heat treatment gave variable elongation values. The .005", .010", and .063" thick material receiving the B' heat treatment had satisfactory elongation. The .025" and .040" thick material did not.

In addition to the standard tensile specimens, notched tensile specimens in the several thicknesses of sheet were tested. These specimens received either an A, B, or P heat treat cycle. Unnotched control specimens were processed only with the notched specimens receiving the P heat treat cycle. The notch ratios for these specimens were as follows:

Thickness (Inch)	NS/UTS [~] P Cycle
.005	.94
.010	.95
.025	.94
.040	.96
.063	1.03

It should be noted that the .063" thick material used in these tests was from heat No. 46979. This heat was defective as mentioned before. No control specimens were run with the notched specimens receiving the A and B Cycles. The notched strengths obtained indicate that the notched strength-ultimate tensile strength ratio would be about 0.9. The test values obtained are given in Tables XXI and XXII.

Tensile, edge compression, flat compression, and shear beam test specimens from three 17-7PH steel sandwich panels were tested. All three panels received the A cycle heat treatment. The brazing was carried out in Convair production facilities by MR&D. All the test results were above the minimum values specified in FMS-0036(C). Although all the test specimen averages

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were above the required minimum values, the skins of panel #1 and core of panel #2 were somewhat below normal in strength. The tensile results from the skins of panel #1 and the flat compression values of panel #2 in Table XXIII may be noted.

CONCLUSIONS:

1. The basic rapid brazing cycle heat treatment under investigation was found to give acceptable mechanical properties when no 1400 F step was included and an aging temperature of 1065 F was used.
2. The use of the rapid brazing cycle with a 1050 F aging temperature gave low elongation values with most of the heats of 17-7PH steel tested.
3. The use of the rapid brazing cycle with a 1075 F aging temperature gave below minimum ultimate strength values for most of the material tested.
4. The average mechanical values of specimens from three 17-7PH steel sandwich panels were all above the minimum specification values.

Standard Tensile Specimen

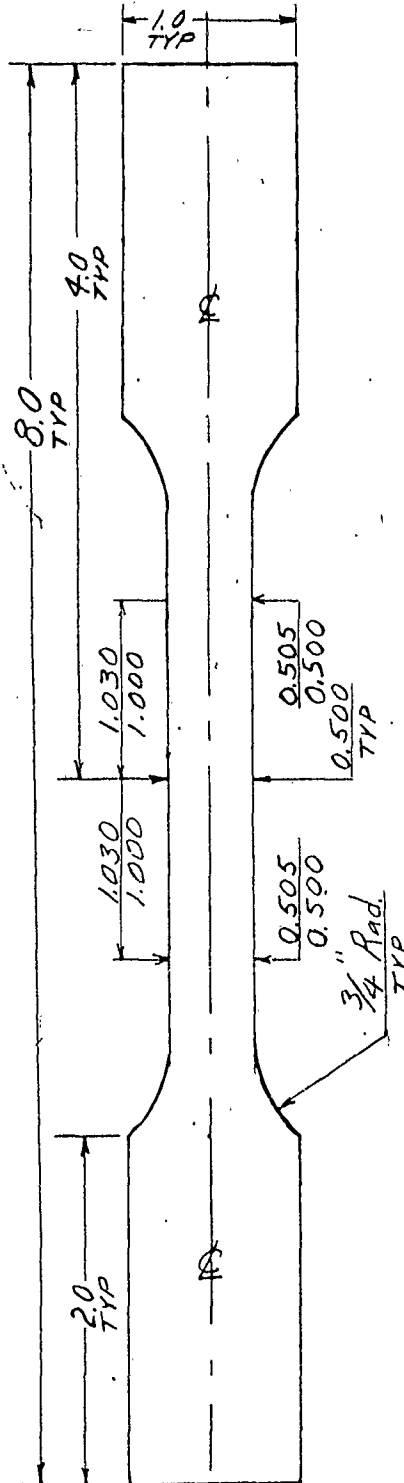


FIGURE-1

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Notch Tensile Specimen

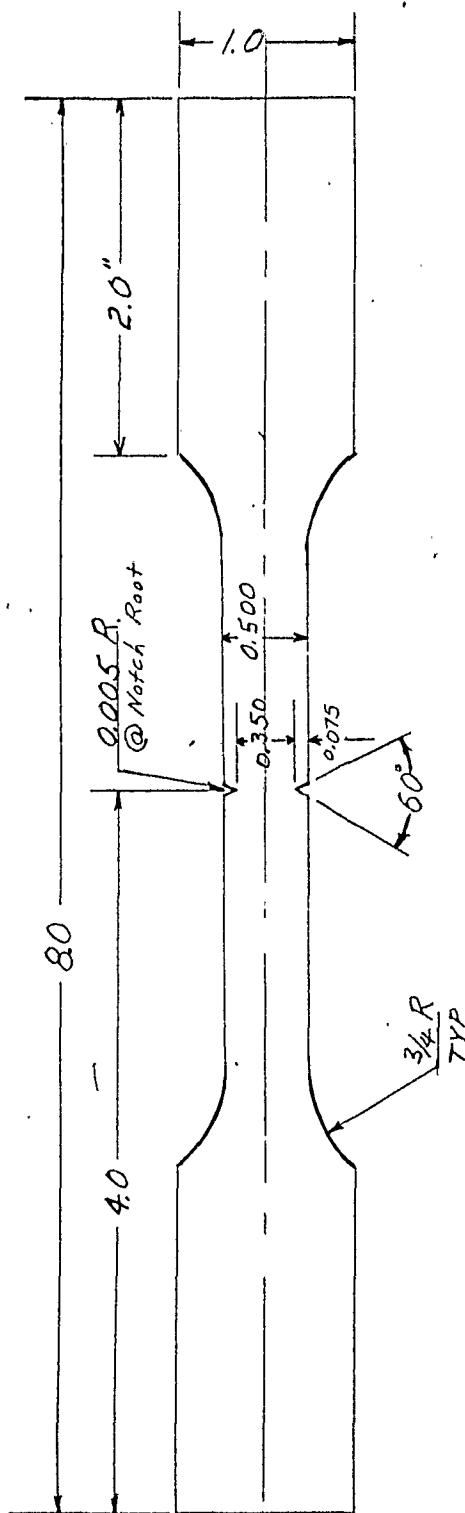


FIGURE-2

Effect of Age Temperature on Ultimate Strength & Percent Elongation after a Rapid Brazing Cycle Heat Treatment

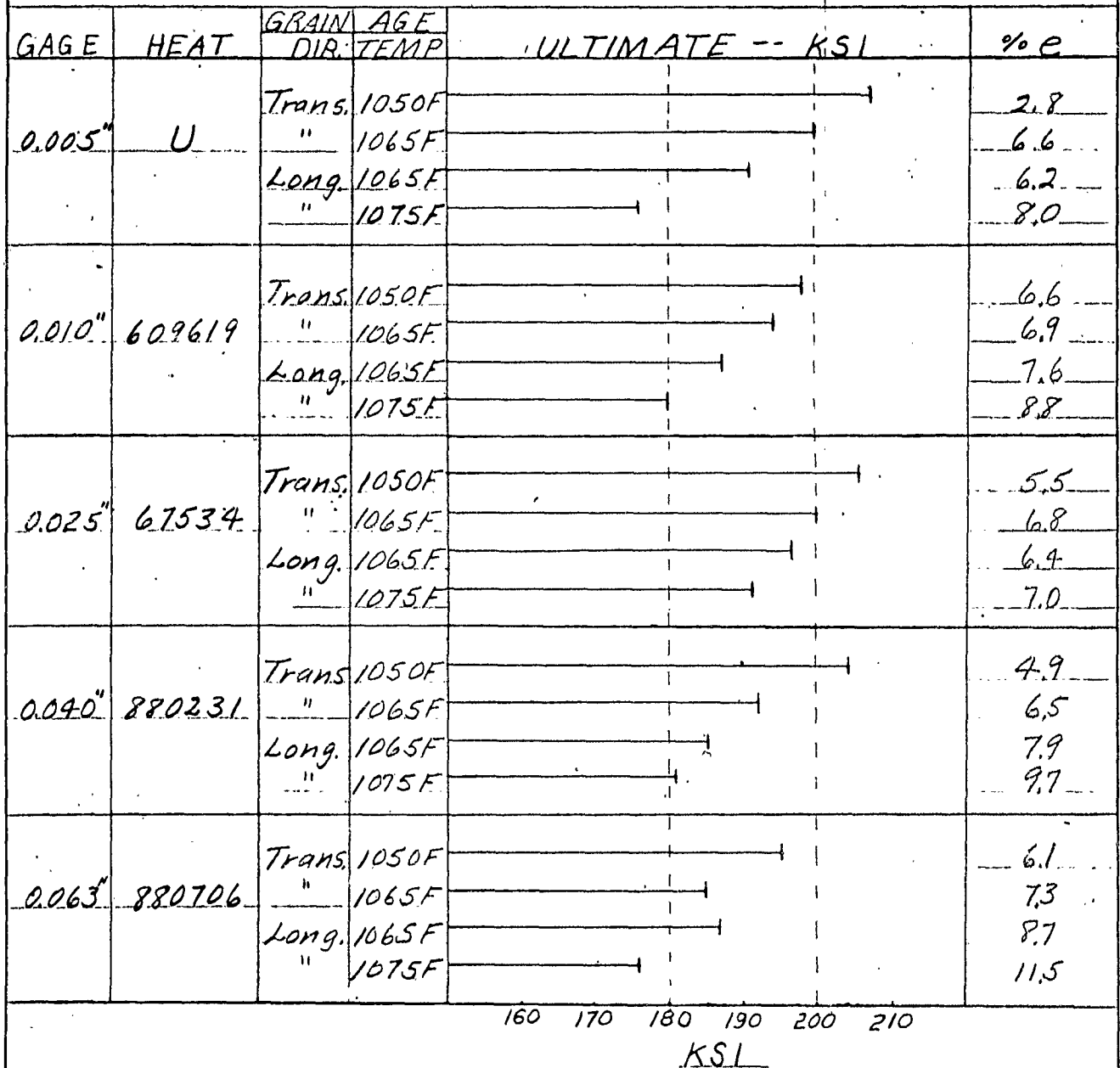


FIGURE-3

TABULATION SHEET 0.010 Gage, 17-7PH Filler Sheet Tensiles -- Batch 1

SAMP NO	HEAT TREAT	GRAIN DIR	GAGE	WIDTH	AREA	YIELD		ULT.		%e
						KSI		KSI		
171-1	A	TRANS.	.0107	.500	.0053	164.1		176.0		5.5
2						161.3		176.0		5.5
3						159.3		174.5		5.5
4						160.3		173.9		5.5
5						160.3		173.2		5.0
6						160.3		172.0		6.0
7						160.0		173.0		6.0
8						159.3		172.6		6.0
9						158.4		172.1		6.0
10						156.6		173.2		6.0
AVERAGE						160.0		173.6		5.7
111-1	A	LONG.	.0107	.498	.0053	150.9		168.3		6.5
2			.0107	.498	.0053	159.4		169.8		7.0
3			.0107	.498	.0053	156.6		171.7		6.5
4			.0108	.497	.0054	153.7		166.6		6.0
5			.0107	.497	.0053	156.6		171.7		7.0
6			.0108	.498	.0054	153.7		167.6		7.0
7			.0107	.498	.0053	152.9		171.1		7.0
8			.0107	.498	.0053	156.6		170.7		7.0
9			.0107	.498	.0053	156.6		171.1		7.5
10			.0108	.499	.0054	152.7		167.2		7.5
AVERAGE						155.7		169.6		6.9

TABLE II

TABULATION SHEET 0.025 Gage, 17-TPH Filler Sheet Tensiles--Batch 1

SAMP. NO.	HEAT TREAT	GRAIN DIR	GAGE	WIDTH	AREA	YIELD KSI	ULT. KSI	% e
1T2-1	A	TRANS	.0271	.504	.0136	180.1	187.5	4.5
2			.0271	.503		177.5	183.8	4.5
3			.0270	.503		179.4	183.8	4.0
4			.0271	.503		180.5	187.1	4.0
5			.0272	.504		179.1	183.4	4.0
6			.0271	.503		180.1	187.5	4.0
7			.0271	.504		178.6	183.4	4.0
8			.0272	.504		180.5	187.5	4.0
9			.0270	.504		179.4	182.3	4.0
10			.0271	.503		178.3	185.6	4.0
AVERAGE						179.4	185.2	4.1
1L2-1	A	LONG	.0274	.501	.0137	170.8	177.4	5.5
2			.0273	.502	.0137	171.5	177.7	5.0
3			.0274	.502	.0137	168.6	178.1	5.0
4			.0274	.501	.0137	168.2	178.4	5.0
5			.0272	.502	.0136	169.8	175.7	4.0
6			.0272	.501	.0136	172.4	179.8	5.0
7			.0273	.502	.0137	170.8	175.2	5.0
8			.0273	.502	.0137	172.2	182.1	5.0
9			.0271	.502	.0137	172.2	177.0	5.5
10			.0273	.502	.0137	174.4	181.4	5.5
AVERAGE						171.1	178.3	5.0

TABLE III TABULATION SHEET 0010 Gage, 17-7PH Filler Sheet Tensiles--Batch 2

SAMP. NO.	HEAT TREAT	GRAIN DIR	GAGE	YIELD KSI	ULT. KSI	%E
2T1-1	A	TRANS	.0097	178.6	185.7	6.0
2			.0097	176.5	182.6	5.5
3			.0098	177.6	183.7	5.0
4			.0099	176.0	183.0	4.5
5			.0097	177.6	184.7	7.0
6			.0098	176.5	184.7	6.0
7			.0097	176.5	183.7	6.5
8			.0099	184.0	190.4	6.0
9			.0099	181.9	186.2	5.5
10			.0098	178.6	185.7	6.0
AVERAGE				178.4	185.0	5.8
2L1-1	A	LONG	.0100	173.0	181.0	7.5
2			.0098	178.6	183.7	6.5
3			.0098	174.5	181.6	5.0
4			.0099	173.0	182.0	7.0
5			.0097	177.1	186.5	6.0
6			.0098	172.5	180.6	6.0
7			.0097	175.0	184.4	6.0
8			.0098	174.5	184.7	7.0
9			.0097	182.3	188.5	6.0
10			.0100	169.0	178.0	6.0
AVERAGE				175.0	183.1	6.3

TABULATION SHEET 0.025 Gage 17-7PH Filler Sheet Tensiles -- Batch 2

SAMP NO	HEAT TREAT	GRAIN DIR	GAGE	YIELD		ULT.		%E
				KSI	KSI	KSI	KSI	
272-1	A	TRANS	.0249	179.2	187.6			7.5
2				178.4	187.6			8.0
3				180.0	188.0			7.5
4				179.0	186.5			8.0
5				181.6	187.2			5.5
6				182.0	187.2			8.0
7				182.4	187.2			8.0
8				184.0	189.6			8.0
9				182.0	188.4			6.0
10				182.0	187.2			6.5
AVERAGE				181.1	187.6			7.3
272-1	A	LONG	.0249	177.4	184.9			8.5
2				178.2	184.9			8.0
3				176.2	185.3			7.5
4				177.8	185.7			8.0
5				178.4	188.0			8.5
6				178.6	184.9			8.5
7				178.8	186.8			8.0
8				180.2	185.7			8.0
9				179.6	186.4			8.0
10				177.8	185.7			8.0
AVERAGE				178.3	185.8			8.2

TABLE V

TABULATION SHEET 0010 Gage, 17-7PH Filler Sheet Tensiles -- Batch 3

SAMP. NO.	HEAT TREAT	GRAIN DIR.	GAGE	YIELD KSL	ULT. KSL	%E
3TB-1	B	TRANS	.0108	161.1	174.6	9.0
2				159.2	170.9	10.0
3				158.3	171.7	10.0
4				158.0	170.4	9.0
5				161.5	171.1	9.0
3T-1				163.9	175.2	9.0
2				159.2	174.8	9.0
3				163.9	177.8	10.0
4				163.0	176.5	10.0
5				163.0	174.4	9.5
AVERAGE				162.6	173.8	9.4
3LB-1	B	LONG	.0108	161.1	171.7	10.0
2				166.7	174.1	9.0
3				167.6	174.1	9.0
4				168.8	171.7	9.0
5				163.0	173.3	9.0
3L-1				163.9	172.2	9.5
2				165.7	174.4	10.5
3				165.7	172.6	9.0
4				165.7	173.5	9.5
5				166.7	175.2	9.5
AVERAGE				165.0	173.3	9.4

TABULATION SHEET 0025 Gage, 77-7PH Filler Sheet Tensiles -- Batch 3

SAMP NO.	HEAT TREAT	GRAIN DIR.	GAGE	YIELD		ULT.		% E
				KSL	KSL	KSL	KSL	
3TB-1	B	TRANS.	.0248	181.5	188.2			9.0
2				181.2	187.7			10.0
3				181.3	188.1			9.0
4				182.5	189.2			8.5
5				181.7	188.4			8.5
3T1-1				183.4	189.3			9.0
2				183.4	188.9			8.5
3				184.3	189.4			8.5
4				183.5	189.8			8.5
5				183.8	189.4			8.5
AVERAGE				182.6	188.9			8.8
3LB-1	B	LONG.	.0250	180.4	186.4			8.0
2				180.4	186.8			8.0
3				178.0	184.7			9.0
4				178.0	184.3			10.5
5				178.3	184.6			10.5
3L-1			.0249	178.5	185.1			9.5
2				182.0	187.6			8.5
3				180.8	187.7			8.0
4				180.9	187.3			8.0
5				177.7	184.4			9.0
AVERAGE				179.5	185.9			8.9

TABLE VII TABULATION SHEET 0.010 Gage, 17-7PH Filler Sheet Tensiles -- Batch 4

SAMP. NO.	HEAT TREAT	GRAIN DIR.	GAGE	YIELD		UTL.	%E
				KSI	KSI		
4TB-1	B	TRANS.	0098	1774	1854		8.0
2				1794	1851		7.0
3				1774	1834		7.0
4				1774	1855		5.0
5				1784	1850		6.0
4T-1			0097	1810	1891		5.5
2				1844	1901		5.5
3				1820	1901		5.5
4				1840	1902		4.0
5			0098	1798	1878		5.0
AVERAGE				1811	1872		5.9
4LB-1	B	LONG	0098	1781	1862		5.5
2				1788	1848		6.0
3				1788	1845		6.5
4				1794	1859		9.0
5				1794	1855		8.0
4L-1				1814	1855		6.0
2				1804	1855		6.0
3				1794	1845		6.0
4				1784	1845		4.5
5				1798	1858		5.0
AVERAGE				1794	1853		6.2

TABLE VIII TABULATION SHEET 0025 Gage, 17-7PH Filler Sheet, Tensiles - Batch 4

SAMP. NO.	HEAT TREAT	GRAIN DIR.	GAGE	YIELD		ULT.		%E
				KSI	KSI	KSI	KSI	
4TB-1	B	TRANS	0248	186.5	192.5			6.0
2				186.9	192.9			6.0
3				186.5	195.2			5.0
4				186.9	192.9			6.0
5				185.3	189.3			6.0
4T-1				185.7	190.5			8.0
2				189.3	194.8			7.0
3				186.1	193.3			7.0
4				186.9	192.5			7.0
5				187.3	193.7			7.0
AVERAGE				186.7	192.7			6.5
4LB-1	B	LONG	0248	186.5	192.1			8.0
2				182.5	188.1			8.0
3				186.5	191.3			9.0
4				186.9	191.7			9.0
5				188.1	193.3			9.0
4L-1				186.1	191.3			7.0
2				185.7	190.9			7.0
3				188.9	191.3			8.0
4				186.1	191.3			7.0
5				186.1	190.9			7.0
AVERAGE				186.3	191.2			7.9

TABLE IX

TABULATION SHEET HEAT TREAT RESPONSE OF 17-1PH TEST MAT'L

SAMP NO.	HEAT NO.	HEAT TREAT	GRAIN DIR	GAGE	YIELD KSI	ULT KSI	%C
DT-1	U	ARMCO TRANS	.0050		180.4	196.0	6.5
2					178.4	194.0	7.0
3					178.0	194.8	7.0
AVERAGE					178.9	194.9	6.8
DT-4	V	ARMCO TRANS	.0050		181.2	189.2	6.5
5					182.0	189.2	6.5
6					180.4	187.6	6.5
AVERAGE					181.2	189.7	6.5
DT-7	X	ARMCO TRANS	.0100		204.0	212.0	4.5
8					205.0	213.0	4.5
9					200.0	209.0	4.5
AVERAGE					203.0	211.3	4.5
2DT-1	66885	ARMCO TRANS	.0243		195.0	204.5	6.5
2					194.2	202.9	6.5
3					191.0	200.0	6.5
AVERAGE					193.4	202.2	6.5
2DT-1	67534	ARMCO TRANS	.0280		187.9	199.3	5.5
2					187.1	201.8	5.5
3					184.4	198.9	5.5
AVERAGE					186.5	199.7	5.5
2DT-4	88023	ARMCO TRANS	.0390		192.3	199.0	6.0
5					186.2	194.9	6.5
6					192.1	198.6	6.0
AVERAGE					190.2	197.5	6.3

TABULATION SHEET HEAT TREAT RESPONSE OF 17-7PH TEST MATERIAL

SAMP NO	HEAT NO	HEAT TREAT	GRAIN DIR	GAGE	YIELD		ULT		%C
					ksi	ksi	ksi	ksi	
20T-7 8 9 AVERAGE	46979	ARMCO	TRANS.	.0570	144.6	173.5			10.0
					145.1	173.6			10.0
					144.7	173.2			10.0
					144.8	173.1			10.0
30T-4 5 6 AVERAGE	880706	ARMCO	TRANS.	.0630	178.2	189.9			7.0
					181.4	191.8			7.0
					177.6	188.6			7.0
					179.1	190.1			7.0

TABLE XI

TABULATION SHEET 2005 Gage, 17-7PH Steel Tensiles--Heats U & V

No.	GRAIN DIR.	HEAT		A - Heat Treat		HEAT	A' - Heat Treat		B' - Heat Treat	
				$F_y - k_{si}$	$F_u - k_{si}$		$F_y - k_{si}$	$F_u - k_{si}$	$F_y - k_{si}$	$F_u - k_{si}$
1	Long	U		1904	1952	3.0	186.1	1928	7.0	
2				1904	1938	3.0	185.1	1895	7.0	
3				1908	1954	3.0	183.5	1876	7.0	
4				1892	1942	3.0	183.5	1941	5.0	
5							1875	1922	4.0	
Avg.				1902	1946	3.0	185.1	1912	6.2	
1	Trans	U		2019	2065	3.0	181.9	1947	6.5	1954
2				2031	2069	3.0	190.1	2004	6.0	180.0
3				2027	2069	3.0	195.3	2058	6.0	182.4
4				2023	2065	3.0	184.4	1982	7.5	185.6
5				2031	2069	2.5	187.7	1999	7.0	184.4
6				2027	2054	2.0				
7				2035	2073	2.0				
8				2046	2077	3.0				
9				2031	2069	2.5				
10				2045	2059	2.0				
Avg.				2028	2066	2.6	187.9	1998	6.6	185.6
1	Long	V					191.0	1981	3.0	
2							182.0	1925	5.0	
3							187.1	1950	4.0	
4							191.0	1975	4.0	
5							187.8	1958	4.0	
Avg.										
1	Trans	U		2069	2086	3.0	183.5	1926	5.5	
2				2064	2118	2.5	182.9	1988	5.0	
3				1987	2029	—	182.2	1917	5.0	
4				2035	2097	3.0	181.4	1909	5.0	
5							185.0	1947	5.0	
Avg.				2039	2082	2.8	183.0	1937	5.1	
<p>* The averages of these results are plotted in Figure 3</p> <p>All these specimens were heat treated together to the aging step.</p>										

TABLE XII
TABULATION SHEET 0.010 Gage, 17-1PH Steel Tensiles -- Heat 609619

GRAIN DIR		HEAT	A'-Heat Treat F_y -ksi, F_u -ksi, %C		B'-Heat Treat F_y -ksi, F_u -ksi, %C		HEAT		A'-Heat Treat F_y -ksi, F_u -ksi, %C		B'-Heat Treat F_y -ksi, F_u -ksi, %C				
NO.															
1	Long.	X	198.1	204.6	4.0	200.0	204.9	4.0	X	193.8	199.8	5.0	190.1	197.2	5.0
2			194.4	200.9	3.0	202.0	204.9	3.5		196.2	201.2	5.0	181.1	190.1	5.0
3			199.1	205.6	4.0	200.0	202.9	3.5		177.7	186.7	6.0	190.1	197.2	5.0
4			198.1	204.6	3.5	200.0	203.9	4.0		191.8	196.8	5.0	181.1	189.1	5.5
5			197.2	204.6	3.5	201.0	203.9	4.0		178.7	188.8	6.0	191.2	199.2	5.0
6			196.3	201.8	3.5	199.0	204.0	4.0							
7			191.7	197.2	3.5	202.9	205.9	3.5							
8			197.2	202.8	3.5	201.0	206.9	4.0							
9			197.2	202.8	3.5	202.0	204.9	4.0							
10			192.6	199.1	4.0										
Avg			196.0	202.5	3.6	200.9	204.7	3.8		187.6	194.6	5.4	186.7	194.6	5.1
1	Trans.	X	—	201.9	3.0	205.8	207.5	3.5	X	198.2	202.3	4.0	195.6	199.6	4.0
2			193.4	200.9	4.0	200.4	203.0	3.5		197.1	201.2	4.5	187.5	193.5	4.5
3			193.4	200.0	3.5	206.9	210.8	3.5		197.8	203.8	4.0	182.1	194.2	4.0
4			193.4	198.1	3.5	202.9	206.7	2.0		182.1	190.1	5.5	195.6	202.6	3.5
5			192.4	198.1	3.0	203.0	208.0	2.0		193.2	197.2	4.5	197.2	201.2	4.0
6			191.5	198.1	3.0	195.5	200.0	2.5							
7			195.3	202.8	2.5	205.7	210.4	2.5							
8			193.4	200.0	3.5										
9			191.5	198.1	2.0										
10			192.4	200.0	3.0										
Avg			192.9	199.8	3.1	202.9	206.6	2.8		193.7	198.9	4.5	192.6	198.2	4.0
* The averages of these results are plotted in Figure 3. All these specimens were heat treated together up to the aging step.															
NO.	HEAT	Trans. Grain Dir A'-Heat Treat F_y -ksi, F_u -ksi, %C	Long. Grain Dir A'-Heat Treat F_y -ksi, F_u -ksi, %C	Trans. Grain Dir A'-Heat Treat F_y -ksi, F_u -ksi, %C	HEAT	Trans. Grain Dir A'-Heat Treat F_y -ksi, F_u -ksi, %C	Long. Grain Dir A'-Heat Treat F_y -ksi, F_u -ksi, %C	Trans. Grain Dir A'-Heat Treat F_y -ksi, F_u -ksi, %C	HEAT	Trans. Grain Dir A'-Heat Treat F_y -ksi, F_u -ksi, %C	Long. Grain Dir A'-Heat Treat F_y -ksi, F_u -ksi, %C	Trans. Grain Dir A'-Heat Treat F_y -ksi, F_u -ksi, %C	HEAT	Trans. Grain Dir A'-Heat Treat F_y -ksi, F_u -ksi, %C	Long. Grain Dir A'-Heat Treat F_y -ksi, F_u -ksi, %C
1	609619	177.0 198.4 7.0	169.2 185.5 6.0	171.9 197.7 8.0	609619	171.9 197.7 8.0	170.6 191.2 6.5	173.9 191.4 7.0	171.3 195.2 7.0	166.5 191.5 6.0	170.8 193.7 6.9	170.8 193.7 6.9	170.8 193.7 6.9	170.8 193.7 6.9	170.8 193.7 6.9
2		183.0 199.7 6.5	164.1 185.1 10.0	170.6 191.2 6.5		170.6 191.2 6.5	173.9 191.4 7.0	171.3 195.2 7.0	166.5 191.5 6.0	170.8 193.7 6.9	170.8 193.7 6.9	170.8 193.7 6.9	170.8 193.7 6.9	170.8 193.7 6.9	170.8 193.7 6.9
3		179.8 198.8 7.0	182.1 195.3 8.0	173.9 191.4 7.0		173.9 191.4 7.0	171.3 195.2 7.0	166.5 191.5 6.0	170.8 193.7 6.9	170.8 193.7 6.9	170.8 193.7 6.9	170.8 193.7 6.9	170.8 193.7 6.9	170.8 193.7 6.9	170.8 193.7 6.9
4		180.1 197.0 6.0	169.6 182.6 7.0	171.3 195.2 7.0		171.3 195.2 7.0	166.5 191.5 6.0	170.8 193.7 6.9	170.8 193.7 6.9	170.8 193.7 6.9	170.8 193.7 6.9	170.8 193.7 6.9	170.8 193.7 6.9	170.8 193.7 6.9	170.8 193.7 6.9
5		— — —	165.3 184.4 7.0	166.5 191.5 6.0		166.5 191.5 6.0	170.8 193.7 6.9	170.8 193.7 6.9	170.8 193.7 6.9	170.8 193.7 6.9	170.8 193.7 6.9	170.8 193.7 6.9	170.8 193.7 6.9	170.8 193.7 6.9	170.8 193.7 6.9
Avg.		180.0 198.0 6.6	170.1 187.6 7.6	170.8 193.7 6.9		170.8 193.7 6.9	170.8 193.7 6.9	170.8 193.7 6.9	170.8 193.7 6.9	170.8 193.7 6.9	170.8 193.7 6.9	170.8 193.7 6.9	170.8 193.7 6.9	170.8 193.7 6.9	170.8 193.7 6.9

CONVAIR—FORT WORTH
TABULATION SHEET 0.025 Gage, 17-7PH Steel Tensiles -- Heats 67534
67534
66886

TABLE XIII

NO.	GRAIN DIR.	HEAT	A - Heat Treat F_y -ksi, F_u -ksi, %C	B - Heat Treat F_y -ksi, F_u -ksi, %C	HEAT	A' - Heat Treat F_y -ksi, F_u -ksi, %C	B' - Heat Treat F_y -ksi, F_u -ksi, %C
1	Long	66886	220.6 225.6 2.0	208.9 213.8 4.0	67534	190.1 197.6 6.5 *	185.6 192.3 4.5
2			222.9 227.5 4.0	207.3 212.6 4.0		188.8 196.8 6.0	181.6 188.7 5.0
3			214.1 220.6 3.5	204.8 212.5 4.5		188.2 197.3 5.0	186.5 192.9 5.0
4			213.6 220.2 4.0	204.8 211.2 4.0		188.0 196.3 7.0	186.3 193.2 5.0
5			214.9 221.0 4.0	204.0 208.3 4.0		189.4 199.0 8.0	184.6 191.1 5.0
6			219.6 225.0 3.5	211.5 215.5 4.0			
7			223.9 228.2 3.5				
8			214.8 220.2 4.0				
9			217.2 222.6 —				
10			217.6 220.2 3.0				
Avg.			216.0 222.4 3.5	206.9 212.3 4.1		188.9 197.4 6.4 *	184.9 191.6 4.9
1	Trans.	66886	225.8 231.2 1.5	211.7 216.2 2.5	67534	198.1 205.1 7.5 *	186.5 194.4 5.0
2			221.3 226.7 2.0	212.2 218.3 3.0		196.1 200.1 8.0	186.5 195.8 5.0
3			225.3 230.7 1.5	212.6 219.9 2.5		188.4 193.7 7.0	188.6 196.8 5.0
4			223.0 227.6 2.0	210.2 218.0 4.0		190.1 198.8 6.0	184.8 194.4 5.0
5			221.6 226.7 3.0			196.2 203.5 5.5	187.2 195.7 4.5
6			221.2 226.3 2.0				
7			220.8 226.2 2.5				
8			221.7 227.5 2.5				
9			225.1 230.1 2.0				
10			223.3 227.6 1.0				
Avg.			223.0 228.2 2.0	211.7 218.1 3.0		193.8 200.2 6.8	186.7 195.4 4.9
1	Trans.	67534	206.2 211.7 5.5 *				
2			200.0 204.7 5.0				
3			199.6 205.1 5.0				
4			200.1 205.6 5.0				
5			198.4 204.1 7.0				
Avg.			199.3 206.2 5.5				

* The averages of these results are plotted in Figure 3. All these specimens were heat treated together up to the aging step.

CONVAIR—FORT WORTH

TABLE XIV

TABULATION SHEET 0.025 Gage, 17-7 PH Steel Tensiles Heat 66885

NO.	GRAIN DIR	HEAT	A—Heat Treat			B—Heat Treat			HEAT			A'—Heat Treat			B'—Heat Treat		
			F_y -ksi	F_u -ksi	%E	F_y -ksi	F_u -ksi	%E				F_y -ksi	F_u -ksi	%E	F_y -ksi	F_u -ksi	%E
1	Long	66885	206.1	213.7	4.0	200.4	204.0	4.0	66885	180.2	187.3	7.0	185.7	192.9	5.5		
2			205.3	213.4	4.5	200.8	204.4	4.0		179.1	186.2	7.0	187.2	193.2	5.0		
3			210.7	217.6	4.0	200.8	204.8	4.5		182.1	191.5	7.0	186.9	192.1	5.5		
4			203.8	209.9	4.0	200.0	205.3	5.0		180.1	191.5	7.0	186.5	191.7	5.0		
5			204.6	210.3	4.0					182.1	192.7	7.5	188.9	194.7	5.0		
6			201.9	209.2	4.0												
7			208.4	213.7	3.5												
8			202.3	209.2	4.0												
9			204.2	209.2	4.5												
10			208.0	212.6	4.5												
Avg			205.6	211.9	4.0	200.5	204.6	4.4	Avg.	180.7	189.8	7.1	187.0	192.9	5.2		
1	Trans	66885	207.2	215.8	3.0	195.9	203.3	4.0	66885	183.5	189.4	6.0	192.7	199.2	4.0		
2			209.2	216.9	2.5	200.0	206.7	4.0		184.5	188.9	6.0	193.9	202.0	4.0		
3			208.8	214.2	3.0	198.4	204.1	4.0		187.0	195.1	6.0	192.3	198.8	5.5		
4			209.2	215.4	3.0	202.5	206.5	4.0		187.8	194.7	5.5	187.5	197.2	5.0		
5			201.5	208.5	4.0	203.6	207.7	3.5		187.4	195.5	6.0	189.1	196.0	5.0		
6			207.7	215.0	4.0												
7			206.9	215.0	3.0												
8			209.6	216.2	3.0												
9			198.8	206.9	3.5												
10			206.5	214.2	3.0												
Avg			206.6	213.8	3.1	200.1	205.7	3.9	Avg.	186.0	192.7	5.9	191.1	198.6	4.7		

TABLE XV

CONVAIR—FORT WORTH

TABLE XV

TABULATION SHEET 0.040 Gage, 17-7 PH Steel Tensiles -- Heats 880231 Y

NO	GRAIN DIR	HEAT	A - Heat Treat		B - Heat Treat		A' - Heat Treat		B' - Heat Treat	
			F_y -ksi, F_u -ksi, %C	F_y -ksi, F_u -ksi, %C	F_y -ksi, F_u -ksi, %C	F_y -ksi, F_u -ksi, %C	F_y -ksi, F_u -ksi, %C	F_y -ksi, F_u -ksi, %C		
1	Long	Y	187.8	193.2	4.5		180.7	185.6	7.5	*
2			186.6	190.5	4.0		176.4	183.0	8.0	
3			185.3	190.3	5.0		178.1	186.9	8.0	
4			186.7	190.9	4.5		178.8	187.0	8.0	
5			188.5	192.6	4.5		178.4	186.9	8.0	
6			189.0	193.7	6.5					
7			188.2	192.8	5.5					
8			187.1	191.6	5.0					
Avg			187.9	192.0	4.9		178.4	185.9	7.9	*
1	Trans	Y	192.4	197.6	5.0		189.5	195.2	5.0	
2			188.5	194.0	4.5		193.1	198.4	4.0	
3			188.5	193.5	5.0		190.2	196.2	5.5	
4			184.0	188.7	4.0		193.2	198.9	5.5	
5			183.1	191.3	5.0		194.6	200.0	5.0	
6			188.1	195.4	5.5		192.7	199.5	6.0	
7			191.2	196.1	5.5		190.0	195.1	5.5	
8			188.7	195.8	5.5					
9			187.4	195.2	6.0					
10			182.6	195.7	4.5					
Avg			188.0	194.3	5.0		191.9	197.6	5.4	
1	Trans	880231	201.2	205.1	6.0	*				
2			196.9	200.6	4.5					
3			200.7	203.7	4.5					
4			203.2	205.5	4.5					
5			200.0	204.0	5.0					
Avg			200.2	203.8	4.9					

* The averages of these results are plotted in Figure 3

All these specimens were heat treated together up to the aging step.

FQT-2573

* The averages of these results are plotted in Figure 3. All these specimens were heat treated together up to the

TABULATION SHEET 0063 Gage, 17-7PH Steel Tensiles Heats 46979 & 880706

NO.	GRAIN DIR	HEAT	A-Heat Treat			B-Heat Treat			HEAT			A'-Heat Treat			B'-Heat Treat		
			F_y -ksi	F_u -ksi	%C	F_y -ksi	F_u -ksi	%C	F_y -ksi	F_u -ksi	%C	F_y -ksi	F_u -ksi	%C	F_y -ksi	F_u -ksi	%C
4	Long	Z	192.0	196.5	7.0	198.7	202.8	6.0	46979	153.2	165.6	12.0	158.7	170.2	10.5		
			190.6	194.3	6.5	199.4	204.1	6.0		154.1	166.4	11.0	160.7	179.5	10.0		
			190.8	195.1	7.0	192.2	198.1	7.5		—	168.6	11.0	160.5	170.6	11.0		
			190.8	194.5	6.0	193.4	196.6	7.0		—	167.5	12.0	160.9	171.9	10.0		
			190.4	194.7	7.0	193.1	196.3	6.5		—	169.8	12.0	162.1	170.6	10.0		
			191.2	195.6	7.0	192.8	195.6	6.5									
7			191.7	196.2	7.0	197.8	202.5	6.5									
8			189.3	194.3	6.5												
9			192.5	197.5	7.5												
10			192.9	196.7	6.0												
Avg			191.2	195.5	6.8	195.3	199.4	6.6		153.6	167.6	11.6	160.6	171.6	10.3		
1	Trans	Z	192.9	197.3	5.0	201.9	206.3	4.5	46979	150.2	164.9	12.0	161.1	175.3	10.0		
2			195.1	198.3	5.0	197.4	201.6	5.5		150.0	165.8	12.5	160.8	175.4	10.0		
3			193.0	198.7	5.0	198.4	202.3	4.0		150.2	167.2	11.5	162.9	174.3	9.5		
4			194.3	200.6	6.0	196.2	200.0	5.0		—	168.9	11.0	153.4	168.8	9.5		
5			191.2	196.2	8.0	196.9	201.9	5.0		—	166.1	11.0	160.0	172.0	10.0		
Avg			193.0	198.2	5.8	198.2	202.4	4.8		150.1	166.6	11.6	159.6	173.2	9.8		
1	Long	880706							880706	187.8	192.5	7.0	179.2	185.6	7.0		
2										177.7	185.0	9.0	178.8	184.7	7.0		
3										173.5	181.5	8.5	179.9	185.6	7.0		
4										178.8	185.7	8.5	179.6	185.6	7.0		
5										175.3	184.5	9.5	179.1	184.7	7.0		
Avg										178.6	185.9	8.7	179.3	185.2	7.0		
1	Trans	880706	192.3	198.8	*				880706	176.0	180.7	7.5	179.5	185.0	6.0		
2			192.7	197.6	7.5					172.5	181.0	8.0	177.9	181.1	6.5		
3			187.1	192.5	6.5					180.9	188.7	7.0	181.1	184.3	6.5		
4			191.5	194.5	5.5					177.0	187.7	7.0	—	184.5	6.5		
5			191.4	196.4	5.0					172.8	187.0	7.0	180.3	185.8	6.0		
Avg			191.0	196.0	6.1					176.8	185.0	7.3	179.7	184.1	6.3		

* The averages of these results are plotted in Figure 3.
All these specimens were heat treated together up to the aging step.

CONVAIR—FORT WORTH

0.005, 0.010,

TABLE XVII

U, 609619,
67534, 880231
6780706

TABULATION SHEET 0.025, 0.040, & 0.063 Gauge, 17-7PH Steel Tensiles - Heats

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SAMP. NO.	HEAT	HEAT TREAT	HEAT GRAIN DIR	GAGE	YIELD		ULT		%E
					KSI		KSI		
1HL-1	U	A Grade with 1075F Age	LONG	0.005	159.6		172.1		8.0
2					165.8		176.2		9.0
3					169.6		183.3		8.0
4					161.2		172.9		7.0
5					—		179.5		8.0
AVERAGE					164.0		176.8		8.0
3HL-1	609619			0.010	151.3		179.4		9.0
2					—		180.3		9.0
3					144.5		177.9		9.0
4					152.6		180.9		8.0
5					154.2		182.5		9.0
AVERAGE					150.6		180.2		8.8
3HL-1	67534			0.025	183.8		189.4		9.0
2					184.6		191.8		6.0
3					180.1		187.9		6.0
4					174.3		185.6		6.0
5					—		—		—
AVERAGE					180.8		191.0		7.0
2HL-1	880231			0.040	166.8		178.4		10.0
2					167.0		179.8		11.0
3					167.5		181.4		10.0
4					168.2		181.2		10.0
5					174.1		183.1		7.5
AVERAGE					168.7		180.8		9.7
3HL-1	880706			0.063	156.7		173.0		12.0
2					173.3		178.8		12.5
3					165.1		175.9		11.5
4					169.7		179.3		10.5
5					163.8		175.1		11.0
AVERAGE					165.7		176.4		11.5

TABULATION SHEET 0010—Gage, 17-7PH Steel, Std & Notched, Tensiles

SAMP NO.	GAGE	GRAIN DIR	HEAT TREAT	NOTCH RADIUS	ULT ASTM	NS UTS
P-1	0.005	TRANS	P*	NONE	190.9	
2					200.9	
3					195.2	
4					191.7	
5					193.7	
AVERAGE					194.9	0.94
PN-2	0.005	TRANS	P	.0060	167.8	
4				.0058	184.4	
6				.0058	201.1	
7				.0060	178.3	
9				.0058	185.6	
AVERAGE					183.9	
P-6	0.010	TRANS	P	NONE	206.8	
7					206.8	
8					210.3	
9					209.3	
10					209.7	
AVERAGE					208.6	0.95
PN-1	0.010	TRANS	P	.0060	205.6	
3				.0055	211.4	
5				.0058	206.9	
8				.0058	193.6	
10				.0060	176.8	
AVERAGE					198.9	
Note: The 0.005 gage material was from Heat-V						
" 0.010 " " " Heat-X						
P* - Production brazing cycle.						

0.025.

TABLE IX

CONVAIR—FORT WORTH 0.025
TABULATION SHEET 0.040 → Gage, 17-7PH Steel, Std. & Notched, Tensiles

SAMP NO	GAGE	GRAIN DIR	HEAT TREAT	NOTCH RADIUS	UIT KSI	NS UTS
P-11	0.025	TRANS	P	NONE	203.7	
12					202.1	
13					196.4	
14					194.8	
15					200.9	
AVERAGE					199.6	0.94
PN-16	0.025	TRANS	P	.0057	152.8*	} LOADED-2000#/MIN
17				.0058	148.9*	
18				.0055	171.9	
19				.0065	191.1	} LOADED-1000#/MIN
20				.0055	200.0	
AVERAGE					187.7	
P-16	0.040	TRANS	P	NONE	187.8	
17					196.9	
18					200.0	
19					201.8	
20					200.2	
AVERAGE					197.3	0.96
PN-11	0.040	TRANS	P	.0058	193.7	
12				.0060	188.0	
13				.0060	198.6	
14				.0059	193.7	
15				.0057	176.1	
AVERAGE					190.0	
			P- Production brazing cycle			
			*NOT INCLUDED IN AVERAGE			
			Note: The 0.025 gage material was from Heat - 67539			
			" 0.040 " " " Heat - 880231			

TABLE XX

[illegible]

0.025

TABLE XXI

TABULATION SHEET 0040 - Gage, 17-7PH Steel, Notched Tensiles.

SAMP NO.	GAGE	GRAIN DIR	HEAT TREAT	NOTCH RADIUS	ULT		NS	UTS
					ksi			
AN-1	0.025	TRANS	A*	.0045	178.4			
2				.0025	173.9			
3				.0030	176.7			0.86
4				.0025	181.8			
5				.0027	172.5			
AVERAGE					172.7			
BN-20	0.025	TRANS	B*	.0021	182.4			
21				.0025	178.2			
22				.0020	176.8			
23				.0020	183.9			
24				.0030	174.1			
AVERAGE					179.1			
AN-6	0.040	TRANS	A*	.0032	187.7			
8				.0038	196.1			
14				.0025	193.3			0.92
18				.0028	183.2			
19				.0025	179.0			
AVERAGE					187.9			
BN-7	0.040	TRANS	B*	.0025	168.8			
15				.0028	163.3			
16				.0025	171.2			
25				.0030	175.5			
26				.0025	198.9			
AVERAGE					175.5			
Note: The 0.025 gage specimens were from				"			Heat- 67534	
				0.040 "			Heat- 880231	
A* - Rapid brazing cycle without 1400 F							Step	
B* - Rapid brazing cycle with 1400 F							Step	

TABULATION SHEET 0063 Gage, 17-7PH Steel, Notched Tensiles

TABLE XVII

SAMP. NO.	GAGE	GRAIN DIR	HEAT TREAT	NOTCH RAD.	ULT. KSI.
AN-9	0.058	TRANS	A	.0035	175.0
10				.0035	172.4
11				.0037	169.5
12				.0040	176.9
30				.0030	174.8
AVERAGE					173.7
BN-13	0.058	TRANS	B	.0043	177.6
17				.0030	180.2
27				.0030	178.7
28				.0050	178.9
29				.0040	174.5
AVERAGE					178.0
Note: These specimens were taken from					
Heat 46479. This heat did not					
meet minimum specifications after					
a standard Armco TH 1050 heat					
treatment. See Table X					
A-Rapid brazing cycle without 1400F Step					
B-Rapid brazing cycle with 1400F Step					

TABULATION SHEET TESTS ON 17-7PH, BRAZED, SANDWICH PANELS

TABLE XXIII

TYPE	TEST	SKIN GAGE	PANEL - A1		PANEL - A2		PANEL - A3				
			E_1 -Ksi	f_u -Ksi % C	E_2 -Ksi	f_u -Ksi % C	E_3 -Ksi	f_u -Ksi % C			
TENSILE	1	Q010	173.5	187.3	3.5	204.0	212.0	4.5	174.0	183.0	5.0
	2		164.7	178.4	5.5	197.0	212.0	4.0	181.0	190.0	4.5
	3		166.7	182.4	5.5	198.0	209.0	4.5	183.6	187.6	5.0
	4		167.0	179.0	2.0	198.0	210.0	5.5	178.8	182.4	5.5
AVERAGE			168.0	181.8	5.4	199.5	210.7	4.6	178.8	188.2	5.0
			UL-ksi			UL-ksi			UL-ksi		
EDGE COMP - 1	1		165.0			170.5			173.0		
	2		171.7			212.5			174.5		
	3		180.1			192.0			166.0		
	4		169.6			206.0			180.0		
	5		171.3			210.0			169.5		
AVERAGE			171.5			199.2			172.6		
EDGE COMP 1 (50 Hr. Salt Spray)	1		184.4			205.0			174.0		
	2		163.8			204.0			159.5		
	3		—			205.5			163.5		
	AVERAGE		174.1			204.8			165.7		
CORE MODULUS			167.0			83.0			100.0		
CORE			UL-Ri			UL-Ri			UL-Ri		
FLAT COMP - 1	3-15		156.7			94.5			—		
	2		158.5			87.5			155.0		
	3		139.0			93.5			145.0		
	AVERAGE		151.4			91.8			150.0		
SHEAR BEAM - 1	1		117.2			99.0			93.3		
	2		119.7			109.0			98.5		
	3		105.5			90.3			98.0		
	AVERAGE		114.1			99.4			96.6		
ELEV. TEMP. SHEAR (900F)			527			29.5			44.1		

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SUPPLEMENTAL INFORMATION

A. General Dynamics/Fort Worth (Convair) Specification FMS-0036 and drawing 4FTT110 are referenced in this report for brazed sandwich panel test specimen preparation and testing procedures. Basically these procedures were as follows:

1. Edgewise Compression Test

- a. Specimen size was 2.00" x 3.00" x panel thickness.
- b. All edges are filed smooth to remove nicks and saw cuts and filled with a soft machinable plastic material.
- c. The 2.00" edges are then machined square and parallel to a tolerance of ± 0.001 inch per lineal inch.
- d. The test machine loading lead and platen are checked for parallelism and necessary adjustments made by shimming to insure parallelism. Test specimens are placed in the machine with the 3.00" edges normal to the bearing surfaces.
- e. Testing is accomplished by applying a continuous load to the 2.00" edges at a rate of 8,000 pounds per minute until failure.

2. Edge Compress Test After Salt Spray

Specimen size, preparation and testing procedure is the same as shown above except prior to testing the specimens are subjected to a salt spray test for 50 hours in accordance with Federal Test Method Standard No. 151, Method 811.

3. Shear Beam and Core Modulus Test

- a. Specimen size was 2.00"x5.00" x panel thickness.
- b. The 5.00" edges are filed and sanded smooth to remove nicks and saw cuts which might induce premature failure.
- c. The specimens are tested as simple supported beams using two different span lengths. The load is applied at mid span at a continuous rate of 500 pounds per minute.
- d. The first loading is made using a 4.00" span and a load-deflection curve is obtained without failing the specimen. Maximum load is limited to approximately 1000 pounds.
- e. The beam span is then changed to 2.00" and the specimen loaded until failure again obtaining a load-deflection curve.
- f. In both cases the load scale and magnification for test machine are adjusted so that the load-deflection curve is from 40° to 70°.

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A. (Continued)

4. Shear Beam at Elevated Temperature

- a. Specimen size and preparation is the same as the shear beams described above.
- b. The specimens are tested as simple supported beams using a 2.00" span with the load applied at mid span.
- c. This set-up is placed in a specially designed furnace and heated to 900° F.
- d. The temperature is allowed to stabilize at 900°F and the load applied at a continuous rate of 500 pounds per minute until failure.

5. Flatwise Compress

- a. Specimen size was 2.00" x 2.00" x panel thickness.
- b. All edges of specimens are filed and sanded smooth to remove nicks and saw cuts which might induce premature failure.
- c. The test machine loading head and platen are checked for parallelism and necessary adjustments made by shimming to insure parallelism. Test specimens are placed in the test machine in a flat position.
- d. Testing is accomplished by applying a continuous compressive load to the face of the test specimen at a rate of 8,000 pounds per minute until failure.

- B. The 17-7PH stainless steel used in all the tests reported was purchased to and met the minimum requirements of Specification MIL-S-25043. This includes that material for which the heat numbers were unknown.